

## **Appendix C**

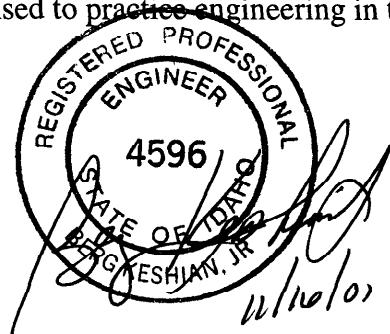
### **Design Calculations**



**Appendix C**  
**Final**  
**Index for the Comprehensive RD/RA Work Plan**  
**V-Tank Remediation Project**

<b>Calculation Number</b>	<b>Title</b>	<b>Calculated by</b>
ABQ01-HP001-RAD	Area Dose Estimates of V-Tank Water and Sludge Removal and Determination of Shielding Requirements During the Transfer of Water and Sludge from V-Tanks	R. Haaker
ABQ02-HP002-RAD	Configuration of V-Tank Wastes for DOT Packaging/Transportation and Determination of Classification with Respect to 10 CFR §61.55	G. Harris
ABQ03-HP003-RAE	Chemical characterization of V-Tank waste for purposes of making a preliminary hazardous waste determination with respect to 40 CFR 761 and 40 CFR § 262.11	S. Collins
ABQ04-HP004-RAD	Required treatment calculation of liquid-phase tank waste in order to ensure compliance with the Waste Acceptance Criteria (WAC) for disposal at Envirocare of Utah	J. Steffes
ABQ05-CE001-RAD	Excavation – Preliminary Estimate of Shoring Requirements	B. Keshian
ABQ06-CE002-RAD	Excavation – Estimated Excavated Soil Volume/Storage Requirements	B. Keshian
ABQ07-CE003-RAD	Lifting Requirements	D. Brennecke
ABQ08-CE004-RAE	Drum Storage/Water Storage/ Decontamination Area Secondary Containment Requirements	D. Brennecke
ABQ09-CE005-RAE	HIC Storage/Drum Filling Staging Area Secondary Containment Requirements	D. Brennecke
ABQ10-CE006-RAC	Storm Water Hydrology	D. Brennecke
ABQ11-CE007-RAB	INEEL/BBWI Utility Location and Type	C. Ehrsam
ABQ12-CE008-RAD	Water Filtration	G. Prior
ABQ13-HP005-RAC	Quantity Determination of V-Tank Pipe Wastes and V-Tank Debris with Respect to DOT Packaging Requirements and Classification per 10 CFR §61.55	G. Harris

The calculations indicated above were prepared under the direction of the following professional engineer, licensed to practice engineering in the State of Idaho:



**ABQ01**

# CALCULATION COVER SHEET



<b>Project:</b>	INEEL V-Tank Remediation Project				<b>Number of Sheets:</b> <i>1 of 58</i>
<b>Site:</b>	INEEL Test Area North, Idaho Falls, Idaho				
<b>Calculation Number:</b>	ABQ01 – HP001		<b>Work Order Number:</b>	12393.002.001	
<b>Subject:</b>	<b>Area Dose Estimates of V-Tank Water and Sludge Removal and Determination of Shielding Requirements During the Transfer of Water and Sludge from V-Tanks</b>				
Rev #	Date:	Revision:	Calculated by:	Checked by:	Approved:
RAA	4/01	60%	Kenneth Schaus & A. Desrosiers	Berg Keshian	Berg Keshian
RAB	5/30/01	90%	Kenneth Schaus & Rick Haaker	Kenneth Schaus	Berg Keshian
RAC	6/27/01	90% Polish	Kenneth Schaus	D. Brennecke	Berg Keshian
RAD	9/27/01	Draft Final	Rick Haaker	Berg Keshian	<i>J. J. Poelj 9/27/01</i>

## **Problem Statement:**

The dose calculation is performed to determine if the solid and liquid contents of the V-1,2, 3 and 9 tanks can be pumped from tanks, stored in HICs and parceled out to 55-gallon drums in a manner that ensure individual exposures maintain ALARA. In addition, based on the area configuration, estimates will be made on the area dose associated with the dewatering of sludge and the temporary storage of up to 80 55-gallon drums maintained within the project's high radiation storage area. Estimates will be made for the optimum use of shielding while transferring waste from each of the V-Tanks to storage HICs then to de-watering drums. The dose estimates are designed to maintain compliance with applicable INEEL administrative dose limits for contract personnel. The equipment contributing to the area dose will be hoses, pumps, HICs and Drums. Sludge HICs should not be a major contributor to area dose since they will be maintained in concrete storage containers while filled with sludge awaiting pumping to drums.

## **Data Evaluation:**

Calculation ABQ02-HP002, Configuration of V-Tank Waste for DOT Packaging/Transportation and Determination of Classification with Respect to 10 CFR 61.55 provided the radionuclide activities for the dose estimates in this calculation. The characterization data was converted from picocuries per gram (pCi/g) or picocuries per liter (pCi/L) to curies (Ci) based on the quantity of material place in drums, hoses and pumps. Both average and maximum activity values were used to estimate area dose rates in hoses, and pumps.

The average activity was used for drums since the sludge is considered to be homogenously mixed. The dose rates on contact and at 100cm were then calculated, limited to < 4 curies of Sr-90, and < 15g of fissile material per 55-gallon drum. The sludge HICs will not be used to ship dewatered sludge and are only used as temporary holding tanks while contents are awaiting parcelling into 55 gallon drums.

## **Sources of Data:**

### V-Tank Waste Volumes Classifications from:

Calculation ABQ02-HP002, Configuration of V-Tank Wastes for DOT Packaging/Transportation and Determination of Classification with Respect to 10 CFR §61.55.

Duratek Polyethylene HICs Dimensions and Volumes,; downloaded from website,  
<http://www.duratekinc.com/>)

### V-Tank Radiation Dose Rate Data and waste characterization from:

Comprehensive Remedial Investigation/Feasibility Study ( RI/FS) for the Test Area North (TAN), DOE-ID, 1997, Operable Unit (OU) 1-10 at the Idaho National Engineering and Environmental Laboratory U.S. Department of Energy Idaho Operations Office, DOE/ID-10557, November 1, 1997

Lockheed Martin Idaho Technologies Company, March 10, 1998, Carolyn S. Blackmore, Criticality Safety Issues Associated with the Test Area North V-Tanks-CSB-004-98

Dose Calculations Performed by QA Safety, Inc. using MicroShield v5.03 (5.03-00090).

## **Assumptions:**

1. The contents of each V-Tank will be mixed thoroughly to ensure a homogeneous material and that to the extent practicable, the radioactivity will be essentially uniformly distributed throughout the mixture.
2. Assume that Ba-137m, Co-60, Cs-137,Sr-90 and Y-90 are major nuclides driving dose determinations for Tank waste.
3. The dose calculation for dewatered were based on removal of 30% water from an originating sludge density of 1.02 g/cc. This resulted in an estimated density of 1.45 g/cc. Based on reducing the water content of the sludge by 30%, the sludge will meet the waste processor requirement of solid waste liquid that "contains as little free standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume," 10 CFR §61.56, Waste Characteristics (ATG).

4. Water HICs will not be a significant contributor to area dose rates since the radioactive concentration are estimated to be in the millicurie range in addition to being shielded by water.

### **Calculation:**

The radionuclide activities from the characterization data provided in the Comprehensive Remedial Investigation/Feasibility Study ( RI/FS) for the Test Area North (TAN), DOE-ID, 1997, Operable Unit (OU) 1-10 was used to provide characterization data. The characterization data was converted from picocuries per gram (pCi/g) or picocuries per liter (pCi/L) to curies (Ci). Average and maximum data values were then calculated for each radionuclide for each V-Tank waste solid or sludge phase. Note that an average and maximum data value was not calculated for each tanks liquid phase since only one sample result was reported.

The total activity for each V-Tank was then calculated using an average activity. The data was then copied into the appropriate configuration data sheets (with respect to a particular packaging configuration and design of hoses and pumps) by manipulating the percent of total activity and dose rates before copying. For example, if a particular tank was pumped in two phases. The first phase would be removing the water without mixing. The contaminated water content of each tank would be pumped into individual HICs. The second phase would be to pump the sludge from each tank into separate HICs. The removal of concentrated sludge would create the greatest exposure in the hoses, pump, and HICs during the removal. The greatest contributor of dose would be from the de-watered 55-gallon drums. These drums will have their moisture content reduced to approximately 30% of their original moisture content. This level of moisture will contain as little free standing and noncorrosive liquid as is reasonably achievable, but in no case more than 1% free liquid by volume.

### **Discussion:**

Radiological characterization data and waste volumes obtained from calculation ABQ02-HP002 spread sheets were used to estimate dose rates from drums, HICs, pumps and hoses. Based on an estimated storage area of 80 drums, a shielded dose calculation was used to estimate general area dose rate around the drum storage area. Based on the Project Work Plan, HICs will be maintained in Rad Vault Concrete Storage Containers while being filled with the V-1, 2, 3, and 9 pre-dewater sludge. The sludge will be maintained segregated based on the tank it was extracted from. All the tank liquids will be transferred into liquid HICs , (PL8-120MT) and water storage tanks. Based on the shielding provided by the Rad Vault and the amount of activity in the water the expected dose from the sludge and water storage containers will be < 2 mr/hr at 1 meter.

**Table 1. Results of Configuring V-Tank Sludge Phase Wastes by Using Average Data Values.**

Tank #	V-1	V-2	V-3	V-9
Estimated Total Solid/Tank (gallons)	520	520	652	250
Total Activity/Tank (Ci)	37.9	45.7	77.0	12.6
Amount of sludge/drum (gal.)	25	25	25	22.73
No. of drums	20	20	26	11
Total Activity/drum (Ci)	1.89	2.285	2.65	1.15
Total Sr-90/drum (Ci)	.775	1.1	1.875	0.562
Total Cs-137/drum (Ci)	.708	.62	.658	0.490
Total Co-60 (Ci)	.0195	.0215	.0162	.0827
Classification of drums (10CFR 61.55)	Class B	Class B	Class B	Class B

Table 1 represents a scenario using average data values. The average data value would be representative of a homogenous mixture of liquid sludge and would most likely occur when transferring liquid sludge from V-Tanks to sludge HICs. Additional mixing would also occur when liquid sludge was

transferred to 55-gallon drums. If verification sampling of the V-Tank sludge wastes closely approximates the concentrations indicated by the existing characterization data, then it would be reasonable to expect the sludge wastes of average concentrations could be containerized into approximately (80) 55-gallon drums.

## **Summary**

Based on the MicroShield v5.03 Calculations the average concentrations of sludge in each drum/tank was used to estimate contact and dose at 100cm in mR/hr. Configuration used consisted of 55 gal steel container (drums), 2" ID X 50' Hoses, 2" Cylinders 1.5' in height representing pumps.

A review of waste stream information on V-Tanks 1, 2, 3 and 9 indicated that the most limiting energies (those nuclides contributing to the greatest area dose) were Co-60, Cs-137, and Sr-90.

An evaluation was done of each drum (filled and dewatered), using the mid height to determine the dose rate associated with each drum from each tank on contact and at a distance of 100 cm. These results are summarized on Table 2 and show that the sludge from the V2 tank results in the highest dose rates. These levels would contribute considerable individual dose while working with or around drums.

In order to limit dose, a shielded over pack will be used (see Waste Management Plan) to protect workers to an acceptable level.

Dewatered 55-gallon sludge drums will be placed in a temporary high-radiation storage area. Up to 80 drums will be maintained in this area. Based on MicroShield v5.03 calculation (STORAGEM.MSS) a 10" concrete shield placed between the drums and the general work area will reduce the dose rate at the high radiation area fence to 16mR/hr and to 10 mR/hr at 10 feet from the fence. The dose rate at the access area would be < 2mr/hr.

If the actual tank content closely represents the concentrations indicated by the existing characterization data, then it is reasonable to expect the sludge wastes can be containerized into approximately (80) 55-gallon drums.

**Table 2. Summary of Exposure Results (mRem/hr) when Configuring V-Tank Sludge into Drums**

TANK #	V-1	V-2	V-3	V-9
Estimated Exposure from average sludge concentrations at fill height. @ contact/ @ 100 cm (mR/hr)	2957/61	6875/233	2568/48	2598/41
Estimated Density of Solids Pumped from HICs (g/cc)	1.1	1.1	1.1	1.1
Estimated Density of Dewatered sludge in Drums	1.45	1.45	1.45	1.45
Amount of sludge/drum (gal.)	26	52	24	18
Height of drums filled prior to dewatering (cm)	43	80	37	27
Height of drums post dewatering (cm)	30	59	26	19
Estimated exposure from avg. sludge concentrations after dewatering at mid height. @ contact/@ 100 cm (mR/hr)	3216/49	7398/193	2755/39	2741/34
Total Sr-90/drum (Ci) (28 cm)	.745	2.75	2.0	.44
Total Cs-137/drum (Ci) (28 cm)	.885	1.55	.70	.38
Total Co-60 (Ci) (28 cm)	2.44 E-2	5.39 E-1	1.74 E-2	6.5 E-2
Total Activity	1.9	2.28	2.83	.90

**Table 3. Summary of Exposure Results (mRem/hr) when Configuring V-Tank Sludge through Hoses and Pipes**

EQUIPMENT TYPE	PUMPS	HOSES
Estimated Density of Solids Pumped from HICs (g/cc)	1.02	1.02
Estimated Exposure in mR/hr @100cm, from average sludge concentrations	6.8	21.3
Estimated Exposure in mR/hr @contact, from average sludge concentrations	1268	659
Total Sr-90 (Ci) (28 cm)	8.39 E -2	1.39 E 0
Total Cs-137 (Ci) (28 cm)	3.02 E -2	5.03 E -1
Total Co-60 (Ci) (28 cm)	1.33 E-3	2.16 E -2

## List of Attachments

<u>Attachment</u>	<u>Title</u>
1	<b>Input Data and Transmittal from R. Haaker 9/27/91</b>
2	<b>V-1 Tank Before and After Dewatering</b>
3	<b>V-2 Tank Before and After Dewatering</b>
4	<b>V-3 Tank Before and After Dewatering</b>
5	<b>V-9 Tank Before and After Dewatering</b>
6	<b>Hose 50 Feet Long 2" Diameter Tank V-1, V-2 and V-3</b>
7	<b>Pumps 2" Hose *2 Maximum Conc. Tanks V-1, V-2, and V-3</b>
8	<b>Dose from Drums in Storage with and without Shielding with Concrete</b>

**Attachment 1**

**Input Data and Transmittal from R. Haaker 9/27/91**

## Transmittal Note.txt

Berg - I have done the Microshield simulations for the v tank drums and storage areas.  
I have reviewed my work against the agreed to model inputs. My Review was completed this morning, 9-27-01. Since I am delivering the information by e-mail, I cannot provide copies this morning that have the date and my initials in the upper right corner of the each microshield run (Date and By blanks). I am authorizing you to write that information in on my behalf.

Thanks for the opportunity to support Weston in this work.

Rick Haaker, AQ Safety, Inc., 9/27/01

**Attachment 2**

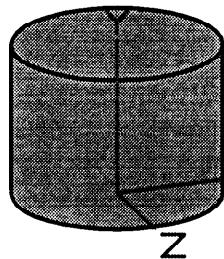
**V-1 Tank Before and After Dewatering**

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : V11-1.MS5  
Run Date: September 26, 2001  
Run Time: 4:26:29 PM  
Duration : 00:00:08

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: V1 before**  
**Description: V1 before dewatering**  
**Geometry: 7 - Cylinder Volume - Side Shields**



**Source Dimensions**

Height	43.0 cm	1 ft 4.9 in
Radius	28.6 cm	11.3 in

**Dose Points**

	X	Y	Z
# 1	29.7 cm 11.7 in	21.5 cm 8.5 in	0 cm 0.0 in
# 2	129.7 cm 4 ft 3.1 in	21.5 cm 8.5 in	0 cm 0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	1.10e+05 cm <sup>3</sup>	Water	1.1
Transition	.1 cm	Iron	7.86
Air Gap		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm <sup>3</sup>
Ba-137m	8.3721e-001	3.0977e+010	7.5768e+000	2.8034e+005
Co-60	2.4400e-002	9.0280e+008	2.2082e-001	8.1704e+003
Cs-137	8.8500e-001	3.2745e+010	8.0093e+000	2.9634e+005

**Buildup**

The material reference is : Source

**Integration Parameters**

Radial	20
Circumferential	20
Y Direction (axial)	20

**Results - Dose Point # 1 - (29.7,21.5,0) cm**

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm <sup>2</sup> /sec	Fluence Rate No Buildup	Exposure Rate mR/hr	Exposure Rate With Buildup
0.0318	6.413e+08	1.712e-01	1.586e+00	1.426e-03	1.321e-02

Page : 2

DOS File : V11-1.MS5

Run Date : September 26, 2001

Run Time: 4:26:29 PM

Duration : 00:00:08

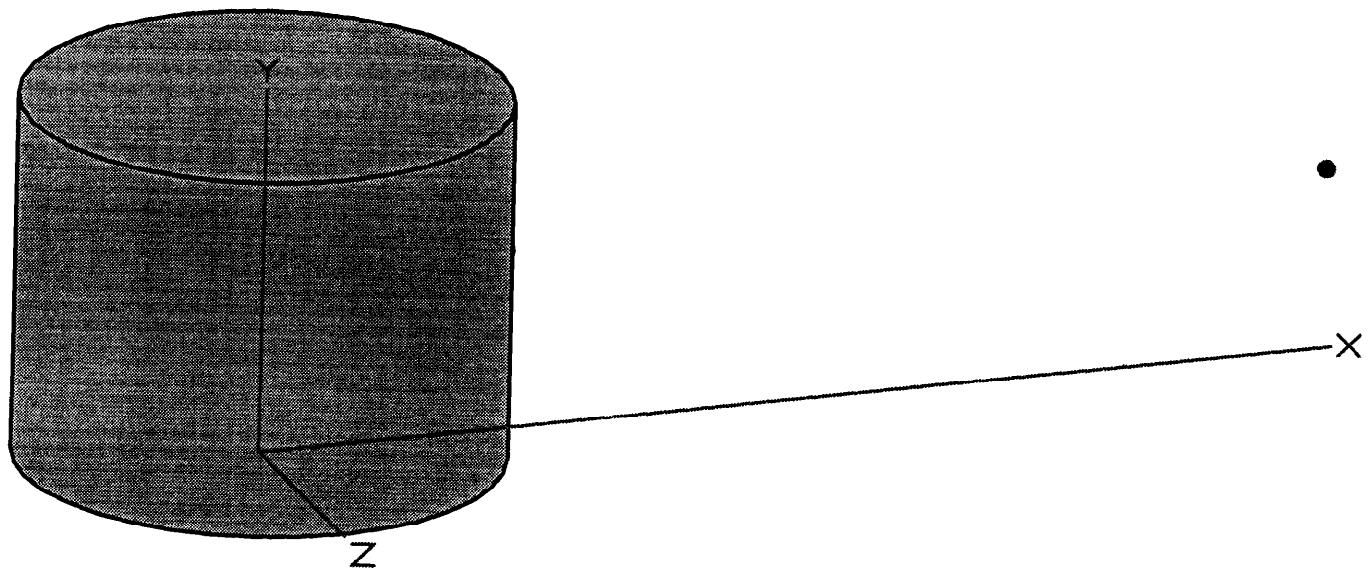
<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>MeV/cm<sup>2</sup>/sec</u>	<u>No Buildup</u>	<u>With Buildup</u>	<u>mR/hr</u>
0.0322	1.183e+09	3.965e-01	3.761e+00	3.191e-03	3.026e-02
0.0364	4.306e+08	1.091e+00	1.293e+01	6.200e-03	7.345e-02
0.6616	2.787e+10	5.553e+05	1.370e+06	1.077e+03	2.657e+03
0.6938	1.473e+05	3.142e+00	7.577e+00	6.067e-03	1.463e-02
1.1732	9.028e+08	4.117e+04	7.958e+04	7.357e+01	1.422e+02
1.3325	9.028e+08	4.943e+04	9.109e+04	8.576e+01	1.580e+02
TOTALS:	3.193e+10	6.459e+05	1.541e+06	1.236e+03	2.957e+03

**Results - Dose Point # 2 - (129.7,21.5,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>MeV/cm<sup>2</sup>/sec</u>	<u>No Buildup</u>	<u>With Buildup</u>	<u>mR/hr</u>
0.0318	6.413e+08	1.709e-03	1.507e-02	1.424e-05	1.255e-04
0.0322	1.183e+09	3.902e-03	3.515e-02	3.141e-05	2.829e-04
0.0364	4.306e+08	9.320e-03	1.032e-01	5.295e-05	5.864e-04
0.6616	2.787e+10	8.214e+03	2.796e+04	1.592e+01	5.421e+01
0.6938	1.473e+05	4.691e-02	1.556e-01	9.057e-05	3.003e-04
1.1732	9.028e+08	6.864e+02	1.752e+03	1.227e+00	3.132e+00
1.3325	9.028e+08	8.482e+02	2.044e+03	1.472e+00	3.546e+00
TOTALS:	3.193e+10	9.749e+03	3.176e+04	1.862e+01	6.089e+01

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DOS File : V11-1.MS5  
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Run Time: 4:26:29 PM  
Duration : 00:00:08

13758

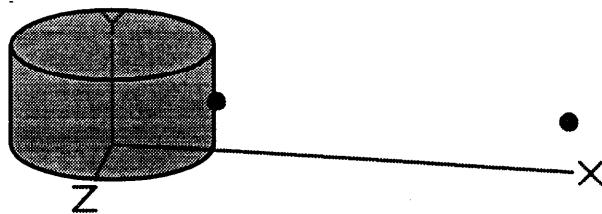


**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : A11-45.MS5  
Run Date: September 26, 2001  
Run Time: 5:12:11 PM  
Duration : 00:00:08

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: V1 drum after**  
**Description: V1 drum after dewatering**  
**Geometry: 7 - Cylinder Volume - Side Shields**



**Source Dimensions**

Height	30.0 cm	11.8 in
Radius	28.6 cm	11.3 in

**Dose Points**

	X	Y	Z
# 1	29.7 cm 11.7 in	15 cm 5.9 in	0 cm 0.0 in
# 2	129.7 cm 4 ft 3.1 in	15 cm 5.9 in	0 cm 0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	7.71e+04 cm <sup>3</sup>	Water	1.45
Transition	.1 cm	Iron	7.86
Air Gap		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	μCi/cm <sup>3</sup>	Bq/cm <sup>3</sup>
Ba-137m	8.3721e-001	3.0977e+010	1.0860e+001	4.0182e+005
Co-60	2.4400e-002	9.0280e+008	3.1651e-001	1.1711e+004
Cs-137	8.8500e-001	3.2745e+010	1.1480e+001	4.2476e+005

**Buildup**

The material reference is : Source

**Integration Parameters**

Radial	20
Circumferential	20
Y Direction (axial)	20

**Results - Dose Point # 1 - (29.7,15,0) cm**

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm <sup>2</sup> /sec	Fluence Rate MeV/cm <sup>2</sup> /sec	Exposure Rate mR/hr	Exposure Rate mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.0318	6.413e+08	1.883e-01	1.750e+00	1.568e-03	1.458e-02

Page : 2

DOS File : A11-45.MS5

Run Date: September 26, 2001

Run Time: 5:12:11 PM

Duration : 00:00:08

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		MeV/cm <sup>2</sup> /sec	No Buildup With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.0322	1.183e+09	4.365e-01	4.152e+00	3.513e-03	3.341e-02
0.0364	4.306e+08	1.206e+00	1.427e+01	6.852e-03	8.109e-02
0.6616	2.787e+10	6.004e+05	1.489e+06	1.164e+03	2.887e+03
0.6938	1.473e+05	3.398e+00	8.238e+00	6.560e-03	1.590e-02
1.1732	9.028e+08	4.458e+04	8.703e+04	7.966e+01	1.555e+02
1.3325	9.028e+08	5.357e+04	9.980e+04	9.294e+01	1.732e+02
TOTALS:	3.193e+10	6.986e+05	1.676e+06	1.337e+03	3.216e+03

**Results - Dose Point # 2 - (129.7,15,0) cm**

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		MeV/cm <sup>2</sup> /sec	No Buildup With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.0318	6.413e+08	1.361e-03	1.199e-02	1.133e-05	9.990e-05
0.0322	1.183e+09	3.105e-03	2.796e-02	2.499e-05	2.250e-04
0.0364	4.306e+08	7.368e-03	8.126e-02	4.186e-05	4.617e-04
0.6616	2.787e+10	6.442e+03	2.252e+04	1.249e+01	4.367e+01
0.6938	1.473e+05	3.682e-02	1.255e-01	7.108e-05	2.422e-04
1.1732	9.028e+08	5.444e+02	1.439e+03	9.729e-01	2.571e+00
1.3325	9.028e+08	6.752e+02	1.687e+03	1.172e+00	2.927e+00
TOTALS:	3.193e+10	7.662e+03	2.565e+04	1.463e+01	4.917e+01

**Attachment 3**

**V-2 Tank Before and After Dewatering**

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1

DOS File : A21-1.MS5

Run Date: September 26, 2001

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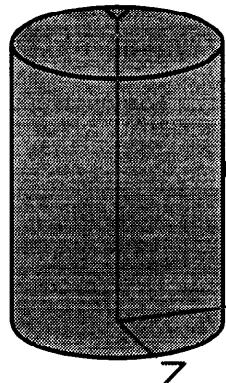
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Date: \_\_\_\_\_

By: \_\_\_\_\_

Checked: \_\_\_\_\_

**Case Title: V2 drum before****Description: V2 drum before dewatering****Geometry: 7 - Cylinder Volume - Side Shields****Source Dimensions**

Height	80.0 cm	2 ft 7.5 in
Radius	28.6 cm	11.3 in

**Dose Points**

	X	Y	Z
# 1	29.7 cm	40 cm	0 cm
	11.7 in	1 ft 3.7 in	0.0 in
# 2	129.7 cm	40 cm	0 cm
	4 ft 3.1 in	1 ft 3.7 in	0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	2.06e+05 cm <sup>3</sup>	Water	1.1
Transition	.1 cm	Iron	7.86
Air Gap		Air	0.00122

**Source Input****Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	uCi/cm <sup>3</sup>	Bq/cm <sup>3</sup>
Ba-137m	1.4663e+000	5.4253e+010	7.1326e+000	2.6391e+005
Co-60	5.3900e-001	1.9943e+010	2.6219e+000	9.7010e+004
Cs-137	1.5500e+000	5.7350e+010	7.5398e+000	2.7897e+005

**Buildup**

The material reference is : Source

**Integration Parameters**

Radial	20
Circumferential	20
Y Direction (axial)	20

**Results - Dose Point # 1 - (29.7,40,0) cm**

Energy MeV	Activity photons/sec	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		MeV/cm <sup>2</sup> /sec	No Buildup	MeV/cm <sup>2</sup> /sec	With Buildup
0.0318	1.123e+09	1.703e-01		1.564e+00	1.418e-03

Page : 2  
 DOS File : A21-1.MS5  
 Run Date: September 26, 2001  
 Run Time: 5:23:50 PM  
 Duration : 00:00:08

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0322	2.072e+09	3.938e-01	3.702e+00	3.169e-03	2.979e-02
0.0364	7.541e+08	1.066e+00	1.247e+01	6.054e-03	7.084e-02
0.6616	4.882e+10	5.435e+05	1.444e+06	1.054e+03	2.799e+03
0.6938	3.253e+06	3.886e+01	1.008e+02	7.503e-02	1.947e-01
1.1732	1.994e+10	5.206e+05	1.077e+06	9.304e+02	1.925e+03
1.3325	1.994e+10	6.292e+05	1.239e+06	1.092e+03	2.150e+03
TOTALS:	9.266e+10	1.693e+06	3.761e+06	3.076e+03	6.875e+03

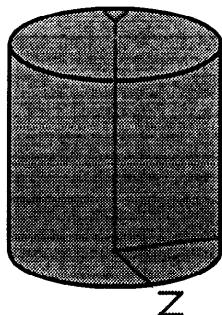
<b>Results - Dose Point # 2 - (129.7,40,0) cm</b>					
<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	1.123e+09	2.628e-03	2.340e-02	2.189e-05	1.949e-04
0.0322	2.072e+09	6.015e-03	5.473e-02	4.841e-05	4.404e-04
0.0364	7.541e+08	1.469e-02	1.645e-01	8.347e-05	9.345e-04
0.6616	4.882e+10	1.373e+04	4.707e+04	2.661e+01	9.124e+01
0.6938	3.253e+06	9.890e-01	3.303e+00	1.909e-03	6.377e-03
1.1732	1.994e+10	1.451e+04	3.728e+04	2.593e+01	6.661e+01
1.3325	1.994e+10	1.794e+04	4.349e+04	3.113e+01	7.546e+01
TOTALS:	9.266e+10	4.618e+04	1.278e+05	8.367e+01	2.333e+02

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : A21-45.MS5  
Run Date : September 26, 2001  
Run Time : 5:33:47 PM  
Duration : 00:00:08

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: V2 drum after**  
**Description: V2 drum after dewatering**  
**Geometry: 7 - Cylinder Volume - Side Shields**



<b><u>Source Dimensions</u></b>			
	<u>Height</u>	<u>59.0 cm</u>	<u>1 ft 11.2 in</u>
	<u>Radius</u>	<u>28.6 cm</u>	<u>11.3 in</u>

<b><u>Dose Points</u></b>			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	29.7 cm	29.5 cm	0 cm
	11.7 in	11.6 in	0.0 in
# 2	129.7 cm	29.5 cm	0 cm
	4 ft 3.1 in	11.6 in	0.0 in

<b><u>Shields</u></b>				
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>	
Source	1.52e+05 cm <sup>3</sup>	Water	1.45	
Transition	.1 cm	Iron	7.86	
Air Gap		Air	0.00122	

**Source Input**

**Grouping Method : Actual Photon Energies**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>uCi/cm<sup>3</sup></u>	<u>Bq/cm<sup>3</sup></u>
Ba-137m	1.4663e+000	5.4253e+010	9.6714e+000	3.5784e+005
Co-60	5.3900e-001	1.9943e+010	3.5551e+000	1.3154e+005
Cs-137	1.5500e+000	5.7350e+010	1.0223e+001	3.7827e+005

**Buildup**

The material reference is : Source

**Integration Parameters**

Radial	20
Circumferential	20
Y Direction (axial)	20

**Results - Dose Point # 1 - (29.7,29.5,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	1.123e+09	1.722e-01	1.588e+00	1.435e-03	1.323e-02

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Page : 2

DOS File : A21-45.MS5

Run Date: September 26, 2001

Run Time: 5:33:47 PM

Duration : 00:00:08

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0322	2.072e+09	3.986e-01	3.762e+00	3.208e-03	3.027e-02
0.0364	7.541e+08	1.086e+00	1.276e+01	6.168e-03	7.249e-02
0.6616	4.882e+10	5.658e+05	1.543e+06	1.097e+03	2.991e+03
0.6938	3.253e+06	4.048e+01	1.078e+02	7.815e-02	2.082e-01
1.1732	1.994e+10	5.469e+05	1.163e+06	9.773e+02	2.079e+03
1.3325	1.994e+10	6.626e+05	1.342e+06	1.150e+03	2.328e+03
TOTALS:	9.266e+10	1.775e+06	4.048e+06	3.224e+03	7.398e+03

**Results - Dose Point # 2 - (129.7,29.5,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	1.123e+09	2.200e-03	1.951e-02	1.833e-05	1.626e-04
0.0322	2.072e+09	5.030e-03	4.557e-02	4.048e-05	3.667e-04
0.0364	7.541e+08	1.211e-02	1.344e-01	6.878e-05	7.637e-04
0.6616	4.882e+10	1.096e+04	3.848e+04	2.125e+01	7.460e+01
0.6938	3.253e+06	7.903e-01	2.704e+00	1.526e-03	5.220e-03
1.1732	1.994e+10	1.170e+04	3.104e+04	2.092e+01	5.547e+01
1.3325	1.994e+10	1.452e+04	3.641e+04	2.520e+01	6.316e+01
TOTALS:	9.266e+10	3.719e+04	1.059e+05	6.736e+01	1.932e+02

**Attachment 4**

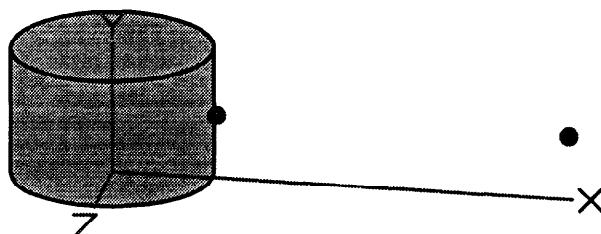
**V-3 Tank Before and After Dewatering**

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : A31-1.MS5  
Run Date: September 26, 2001  
Run Time: 5:50:38 PM  
Duration : 00:00:08

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: V3 drum before**  
**Description: V3 drum before dewatering**  
**Geometry: 7 - Cylinder Volume - Side Shields**



<b>Source Dimensions</b>		
Height	37.0 cm	1 ft 2.6 in
Radius	28.6 cm	11.3 in

<b>Dose Points</b>			
	X	Y	Z
# 1	29.7 cm 11.7 in	18.5 cm 7.3 in	0 cm 0.0 in
# 2	129.7 cm 4 ft 3.1 in	18.5 cm 7.3 in	0 cm 0.0 in

<b>Shields</b>			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	9.51e+04 cm <sup>3</sup>	Water	1.1
Transition	.1 cm	Iron	7.86
Air Gap		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u><math>\mu\text{Ci}/\text{cm}^3</math></u>	<u>Bq/cm<sup>3</sup></u>
Ba-137m	6.6220e-001	2.4501e+010	6.9647e+000	2.5770e+005
Co-60	1.7400e-002	6.4380e+008	1.8301e-001	6.7712e+003
Cs-137	7.0000e-001	2.5900e+010	7.3623e+000	2.7241e+005

**Buildup**

**The material reference is : Source**

**Integration Parameters**

Radial	20
Circumferential	20
Y Direction (axial)	20

**Results - Dose Point # 1 - (29.7,18.5,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.073e+08	1.570e-01	1.457e+00	1.308e-03	1.213e-02

Page : 2

DOS File : A31-1.MS5

Run Date: September 26, 2001

Run Time: 5:50:38 PM

Duration : 00:00:08

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>MeV/cm<sup>2</sup>/sec</u> <u>No Buildup</u>	<u>MeV/cm<sup>2</sup>/sec</u> <u>With Buildup</u>	<u>mR/hr</u> <u>No Buildup</u>	<u>mR/hr</u> <u>With Buildup</u>
0.0322	9.359e+08	3.638e-01	3.455e+00	2.928e-03	2.780e-02
0.0364	3.406e+08	1.003e+00	1.189e+01	5.701e-03	6.756e-02
0.6616	2.205e+10	5.001e+05	1.203e+06	9.694e+02	2.331e+03
0.6938	1.050e+05	2.550e+00	5.993e+00	4.923e-03	1.157e-02
1.1732	6.438e+08	3.314e+04	6.272e+04	5.923e+01	1.121e+02
1.3325	6.438e+08	3.972e+04	7.172e+04	6.891e+01	1.244e+02
TOTALS:	2.512e+10	5.729e+05	1.337e+06	1.098e+03	2.568e+03

**Results - Dose Point # 2 - (129.7,18.5,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		<u>MeV/cm<sup>2</sup>/sec</u> <u>No Buildup</u>	<u>MeV/cm<sup>2</sup>/sec</u> <u>With Buildup</u>	<u>mR/hr</u> <u>No Buildup</u>	<u>mR/hr</u> <u>With Buildup</u>
0.0318	5.073e+08	1.372e-03	1.209e-02	1.143e-05	1.007e-04
0.0322	9.359e+08	3.132e-03	2.818e-02	2.521e-05	2.268e-04
0.0364	3.406e+08	7.460e-03	8.251e-02	4.238e-05	4.688e-04
0.6616	2.205e+10	6.531e+03	2.221e+04	1.266e+01	4.306e+01
0.6938	1.050e+05	3.363e-02	1.114e-01	6.492e-05	2.151e-04
1.1732	6.438e+08	4.919e+02	1.255e+03	8.790e-01	2.243e+00
1.3325	6.438e+08	6.077e+02	1.463e+03	1.054e+00	2.539e+00
TOTALS:	2.512e+10	7.630e+03	2.493e+04	1.459e+01	4.785e+01

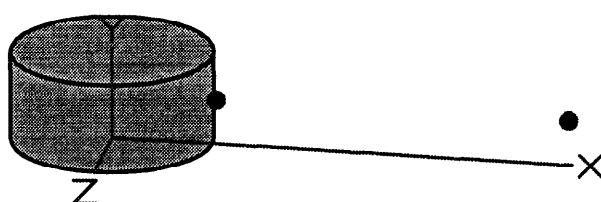
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**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : A31-45.MS5  
Run Date: September 26, 2001  
Run Time: 5:57:21 PM  
Duration : 00:00:08

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: V3 drum after**  
**Description: V3 drum after dewatering**  
**Geometry: 7 - Cylinder Volume - Side Shields**



<b>Source Dimensions</b>		
Height	26.0 cm	10.2 in
Radius	28.6 cm	11.3 in

<b>Dose Points</b>				
	# 1	X	Y	
		29.7 cm 11.7 in	13 cm 5.1 in	Z 0 cm 0.0 in
	# 2	129.7 cm 4 ft 3.1 in	13 cm 5.1 in	0 cm 0.0 in

<b>Shields</b>				
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>	
Source	6.68e+04 cm <sup>3</sup>	Water	1.45	
Transition	.1 cm	Iron	7.86	
Air Gap		Air	0.00122	

**Source Input**  
**Grouping Method : Actual Photon Energies**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>uCi/cm<sup>3</sup></u>	<u>Bq/cm<sup>3</sup></u>
Ba-137m	6.6220e-001	2.4501e+010	9.9114e+000	3.6672e+005
Co-60	1.7400e-002	6.4380e+008	2.6043e-001	9.6360e+003
Cs-137	7.0000e-001	2.5900e+010	1.0477e+001	3.8765e+005

**Buildup**  
The material reference is : Source

**Integration Parameters**

Radial	20
Circumferential	20
Y Direction (axial)	20

**Results - Dose Point # 1 - (29.7,13,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.073e+08	1.722e-01	1.600e+00	1.434e-03	1.332e-02

Page : 2

DOS File : A31-45.MS5

Run Date: September 26, 2001

Run Time: 5:57:21 PM

Duration : 00:00:08

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0322	9.359e+08	3.991e-01	3.795e+00	3.212e-03	3.054e-02
0.0364	3.406e+08	1.102e+00	1.303e+01	6.260e-03	7.404e-02
0.6616	2.205e+10	5.341e+05	1.289e+06	1.035e+03	2.500e+03
0.6938	1.050e+05	2.723e+00	6.428e+00	5.257e-03	1.241e-02
1.1732	6.438e+08	3.544e+04	6.768e+04	6.333e+01	1.209e+02
1.3325	6.438e+08	4.250e+04	7.753e+04	7.373e+01	1.345e+02
TOTALS:	2.512e+10	6.120e+05	1.435e+06	1.172e+03	2.755e+03

<b>Results - Dose Point # 2 - (129.7,13,0) cm</b>					
<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.073e+08	1.084e-03	9.549e-03	9.031e-06	7.954e-05
0.0322	9.359e+08	2.474e-03	2.226e-02	1.991e-05	1.791e-04
0.0364	3.406e+08	5.862e-03	6.461e-02	3.330e-05	3.671e-04
0.6616	2.205e+10	5.108e+03	1.786e+04	9.903e+00	3.462e+01
0.6938	1.050e+05	2.632e-02	8.967e-02	5.082e-05	1.731e-04
1.1732	6.438e+08	3.892e+02	1.028e+03	6.955e-01	1.837e+00
1.3325	6.438e+08	4.827e+02	1.206e+03	8.374e-01	2.092e+00
TOTALS:	2.512e+10	5.980e+03	2.009e+04	1.144e+01	3.855e+01

**Attachment 5**

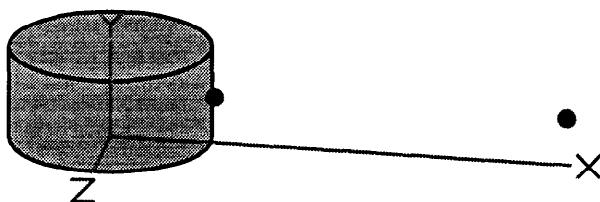
**V-9 Tank Before and After Dewatering**

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : A91-1.MS5  
Run Date: September 26, 2001  
Run Time: 6:08:58 PM  
Duration : 00:00:08

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: V9 drum before**  
**Description: V9 drum before dewatering**  
**Geometry: 7 - Cylinder Volume - Side Shields**



<b>Source Dimensions</b>		
Height	27.0 cm	10.6 in
Radius	28.6 cm	11.3 in

<b>Dose Points</b>			
#	X	Y	Z
# 1	29.7 cm 11.7 in	13.5 cm 5.3 in	0 cm 0.0 in
# 2	129.7 cm 4 ft 3.1 in	13.5 cm 5.3 in	0 cm 0.0 in

<b>Shields</b>				
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>	
Source	6.94e+04 cm <sup>3</sup>	Water	1.1	
Transition	.1 cm	Iron	7.86	
Air Gap		Air	0.00122	

**Source Input**

**Grouping Method : Actual Photon Energies**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u><math>\mu\text{Ci}/\text{cm}^3</math></u>	<u><math>\text{Bq}/\text{cm}^3</math></u>
Ba-137m	3.5948e-001	1.3301e+010	5.1812e+000	1.9170e+005
Co-60	6.5000e-002	2.4050e+009	9.3684e-001	3.4663e+004
Cs-137	3.8000e-001	1.4060e+010	5.4769e+000	2.0265e+005

**Buildup**

The material reference is : Source

**Integration Parameters**

Radial	20
Circumferential	20
Y Direction (axial)	20

**Results - Dose Point # 1 - (29.7,13.5,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	2.754e+08	1.171e-01	1.086e+00	9.755e-04	9.049e-03

Page : 2

DOS File : A91-1.MS5

Run Date : September 26, 2001

Run Time: 6:08:58 PM

Duration : 00:00:08

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0322	5.080e+08	2.714e-01	2.576e+00	2.184e-03	2.074e-02
0.0364	1.849e+08	7.479e-01	8.852e+00	4.249e-03	5.029e-02
0.6616	1.197e+10	3.492e+05	7.916e+05	6.769e+02	1.535e+03
0.6938	3.923e+05	1.223e+01	2.713e+01	2.362e-02	5.238e-02
1.1732	2.405e+09	1.563e+05	2.822e+05	2.793e+02	5.044e+02
1.3325	2.405e+09	1.865e+05	3.222e+05	3.235e+02	5.590e+02
TOTALS:	1.775e+10	6.920e+05	1.396e+06	1.280e+03	2.598e+03

**Results - Dose Point # 2 - (129.7,13.5,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	2.754e+08	7.603e-04	6.684e-03	6.333e-06	5.568e-05
0.0322	5.080e+08	1.734e-03	1.558e-02	1.396e-05	1.254e-04
0.0364	1.849e+08	4.116e-03	4.544e-02	2.338e-05	2.582e-04
0.6616	1.197e+10	3.570e+03	1.213e+04	6.921e+00	2.352e+01
0.6938	3.923e+05	1.265e-01	4.186e-01	2.442e-04	8.082e-04
1.1732	2.405e+09	1.849e+03	4.714e+03	3.305e+00	8.424e+00
1.3325	2.405e+09	2.285e+03	5.497e+03	3.964e+00	9.537e+00
TOTALS:	1.775e+10	7.705e+03	2.234e+04	1.419e+01	4.148e+01

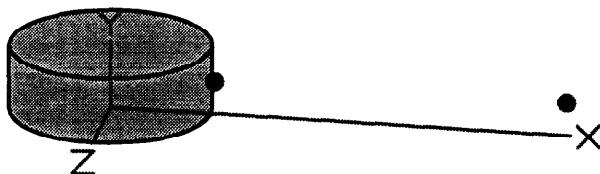
29/58

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : A91-45.MS5  
Run Date: September 26, 2001  
Run Time: 6:16:57 PM  
Duration : 00:00:08

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: V9 drum after**  
**Description: V9 drum after dewatering**  
**Geometry: 7 - Cylinder Volume - Side Shields**



**Source Dimensions**

Height	19.0 cm	7.5 in
Radius	28.6 cm	11.3 in

**Dose Points**

	X	Y	Z
# 1	29.7 cm 11.7 in	9.5 cm 3.7 in	0 cm 0.0 in
# 2	129.7 cm 4 ft 3.1 in	9.5 cm 3.7 in	0 cm 0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	4.88e+04 cm <sup>3</sup>	Water	1.45
Transition	.1 cm	Iron	7.86
Air Gap		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	uCi/cm <sup>3</sup>	Bq/cm <sup>3</sup>
Ba-137m	3.5948e-001	1.3301e+010	7.3627e+000	2.7242e+005
Co-60	6.5000e-002	2.4050e+009	1.3313e+000	4.9258e+004
Cs-137	3.8000e-001	1.4060e+010	7.7830e+000	2.8797e+005

**Buildup**

The material reference is : Source

**Integration Parameters**

Radial	20
Circumferential	20
Y Direction (axial)	20

**Results - Dose Point # 1 - (29.7,9.5,0) cm**

Energy	Activity	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
MeV	photons/sec	MeV/cm <sup>2</sup> /sec	MeV/cm <sup>2</sup> /sec	mR/hr	mR/hr
0.0318	2.754e+08	No Buildup	With Buildup	No Buildup	With Buildup
		1.281e-01	1.189e+00	1.067e-03	9.906e-03

Page : 2

DOS File : A91-45.MS5

Run Date: September 26, 2001

Run Time: 6:16:57 PM

Duration : 00:00:08

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0322	5.080e+08	2.969e-01	2.821e+00	2.389e-03	2.270e-02
0.0364	1.849e+08	8.183e-01	9.664e+00	4.649e-03	5.491e-02
0.6616	1.197e+10	3.668e+05	8.326e+05	7.111e+02	1.614e+03
0.6938	3.923e+05	1.285e+01	2.855e+01	2.481e-02	5.512e-02
1.1732	2.405e+09	1.642e+05	2.988e+05	2.934e+02	5.339e+02
1.3325	2.405e+09	1.960e+05	3.417e+05	3.400e+02	5.927e+02
TOTALS:	1.775e+10	7.270e+05	1.473e+06	1.345e+03	2.741e+03

**Results - Dose Point # 2 - (129.7,9.5,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	2.754e+08	5.946e-04	5.233e-03	4.953e-06	4.359e-05
0.0322	5.080e+08	1.357e-03	1.219e-02	1.092e-05	9.814e-05
0.0364	1.849e+08	3.208e-03	3.533e-02	1.823e-05	2.007e-04
0.6616	1.197e+10	2.783e+03	9.723e+03	5.396e+00	1.885e+01
0.6938	3.923e+05	9.868e-02	3.360e-01	1.905e-04	6.488e-04
1.1732	2.405e+09	1.459e+03	3.852e+03	2.607e+00	6.884e+00
1.3325	2.405e+09	1.809e+03	4.517e+03	3.139e+00	7.836e+00
TOTALS:	1.775e+10	6.051e+03	1.809e+04	1.114e+01	3.357e+01

*31 7 58*

**Attachment 6**

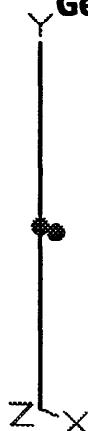
**Hose 50 Feet Long 2" Diameter Tank V-1, V-2 and V-3**

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : HOSE-AV.MS5  
Run Date: May 13, 2001  
Run Time: 6:09:24 AM  
Duration : 00:01:04

File Ref: \_\_\_\_\_  
Date: 5-25-01  
By: RH  
Checked: \_\_\_\_\_

**Case Title: 2 inch hose**  
**Description: 2 inch hose, 50 feet, average conc. of V-1, V-2, V-3**  
**Geometry: 7 - Cylinder Volume - Side Shields**



<b>Source Dimensions</b>		
Height	1.5e+3 cm	50 ft
Radius	2.54 cm	1.0 in

<b>Dose Points</b>			
# 1	X 3.74 cm 1.5 in	Y 762 cm 25 ft	Z 0 cm 0.0 in
# 2	X 102.74 cm 3 ft 4.4 in	Y 762 cm 25 ft	Z 0 cm 0.0 in

<b>Shields</b>			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	3.09e+04 cm <sup>3</sup>	Water	1.02
Transition	.2 cm	Polyethylene CH <sub>2</sub>	0.9
Air Gap		Air	0.00122

**Source Input**  
**Grouping Method : Actual Photon Energies**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u><math>\mu\text{Ci}/\text{cm}^3</math></u>	<u><math>\text{Bq}/\text{cm}^3</math></u>
Ba-137m	3.1816e-001	1.1772e+010	1.0300e+001	3.8110e+005
Co-60	1.2047e-002	4.4573e+008	3.9000e-001	1.4430e+004
Cs-137	3.1816e-001	1.1772e+010	1.0300e+001	3.8110e+005
Sr-90	4.7878e-001	1.7715e+010	1.5500e+001	5.7350e+005
Y-90	4.7878e-001	1.7715e+010	1.5500e+001	5.7350e+005

**Buildup**  
**The material reference is : Source**

**Integration Parameters**

Radial	10
Circumferential	10
Y Direction (axial)	200

**Results - Dose Point # 1 - (3.74,762,0) cm**

Page : 2  
 DOS File : HOSE-AV.MS5  
 Run Date: May 13, 2001  
 Run Time: 6:09:24 AM  
 Duration : 00:01:04

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	2.437e+08	1.278e+02	2.690e+02	1.064e+00	2.241e+00
0.0322	4.496e+08	2.410e+02	5.128e+02	1.940e+00	4.127e+00
0.0364	1.636e+08	1.087e+02	2.567e+02	6.177e-01	1.459e+00
0.6616	1.059e+10	2.191e+05	2.940e+05	4.247e+02	5.700e+02
0.6938	7.271e+04	1.587e+00	2.110e+00	3.064e-03	4.074e-03
1.1732	4.457e+08	1.765e+04	2.161e+04	3.155e+01	3.862e+01
1.3325	4.457e+08	2.038e+04	2.451e+04	3.535e+01	4.253e+01
TOTALS:	1.234e+10	2.576e+05	3.412e+05	4.952e+02	6.590e+02

### **Results - Dose Point # 2 - (102.74,762,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	2.437e+08	3.715e+00	8.531e+00	3.095e-02	7.106e-02
0.0322	4.496e+08	7.019e+00	1.630e+01	5.649e-02	1.312e-01
0.0364	1.636e+08	3.208e+00	8.340e+00	1.823e-02	4.738e-02
0.6616	1.059e+10	6.944e+03	9.530e+03	1.346e+01	1.848e+01
0.6938	7.271e+04	5.035e-02	6.836e-02	9.720e-05	1.320e-04
1.1732	4.457e+08	5.636e+02	6.977e+02	1.007e+00	1.247e+00
1.3325	4.457e+08	6.514e+02	7.909e+02	1.130e+00	1.372e+00
TOTALS:	1.234e+10	8.173e+03	1.105e+04	1.570e+01	2.134e+01

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
 DOS File : HOSE-MXS.MS5  
 Run Date: May 17, 2001  
 Run Time: 6:53:59 AM  
 Duration : 00:00:34

ABQ-HP001-RAA

File Ref:

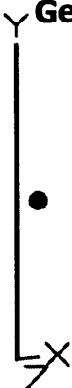
5/17/01 Date: 5/16/01

By: R Harlan

Checked:

(RH)

**Case Title: 2 inch hose + sh**  
**Description: 2 inch hose, 50 feet, max concs. from V-1, V-2, V-3 + shield**  
**Geometry: 7 - Cylinder Volume - Side Shields**

**Source Dimensions**

Height	1.5e+3 cm	50 ft
Radius	2.54 cm	1.0 in

**Dose Points**

# 1	X 102.74 cm 3 ft 4.4 in	Y 762 cm 25 ft	Z 0 cm 0.0 in
-----	-------------------------------	----------------------	---------------------

**Shields**

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	3.09e+04 cm <sup>3</sup>	Water	1.02
Transition	10.0 cm	Concrete	2.35
Air Gap		Air	0.00122

**Source Input****Grouping Method : Actual Photon Energies**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u><math>\mu\text{Ci}/\text{cm}^3</math></u>	<u>Bq/cm<sup>3</sup></u>
Ba-137m	5.0349e-001	1.8629e+010	1.6300e+001	6.0310e+005
Co-60	2.1622e-002	8.0002e+008	7.0000e-001	2.5900e+004
Cs-137	5.0349e-001	1.8629e+010	1.6300e+001	6.0310e+005
Sr-90	1.3993e+000	5.1773e+010	4.5300e+001	1.6761e+006
Y-90	1.3993e+000	5.1773e+010	4.5300e+001	1.6761e+006

**Buildup****The material reference is : Transition****Integration Parameters**

Radial	10
Circumferential	10
Y Direction (axial)	200

**Results**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
0.0318	3.857e+08	8.598e-11	1.789e-10	7.162e-13	1.490e-12

Page : 2

DOS File : HOSE-MXS.MS5

Run Date: May 17, 2001

Run Time: 6:53:59 AM

Duration : 00:00:34

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0322	7.116e+08	3.279e-10	6.929e-10	2.639e-12	5.576e-12
0.0364	2.589e+08	6.268e-08	1.587e-07	3.561e-10	9.015e-10
0.6616	1.676e+10	1.007e+03	4.507e+03	1.953e+00	8.738e+00
0.6938	1.305e+05	8.653e-03	3.735e-02	1.671e-05	7.211e-05
1.1732	8.000e+08	1.530e+02	4.558e+02	2.735e-01	8.145e-01
1.3325	8.000e+08	1.959e+02	5.384e+02	3.398e-01	9.342e-01
TOTALS:	1.972e+10	1.356e+03	5.502e+03	2.566e+00	1.049e+01

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RH  
5-25-01

### Hose results

Exposure Rates in mR/h at Contact (e.g. 1-cm) and 1 m from sludge filled hose:  
Based on Microshield estimates, 50' length, 2" ID, 2mm polyethylene wall.

	mR/h @ 1-cm	mR/h @ 100-cm
Average , tanks V-1, V-2, V-3	659	21.3
Maximum , tanks V-1, V-2, V-3	1060	34.3

### Hose Dimensions

length, ft	cm/in	in/ft	cm
50	2.54	12	1524
radius, in		cm	
1			
volume ( $\pi \cdot r^2 \cdot h$ )			
30,888.89 cm <sup>3</sup>			

### Sludge Concentration values in uCi/cc for Tanks V-1, V-2, V-3

For Hose Calculations

Concentrations taken from Microshield drum simulations

Average individual concentrations	Cs-137	Co-60	Sr-90
V1		8.9454	0.24714
V2		14.303	0.71765
V3		7.7304	0.19089
Average of Average concentrations		10.3	0.39
			15.5

51050

RH  
5-25-01

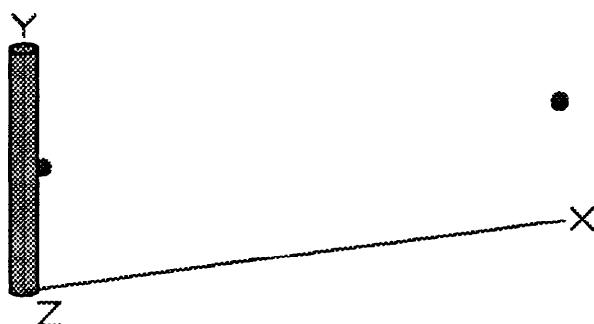
Maximum individual concentrations	Cs-137	Co-60	Sr-90
V1	16.283	0.45879	14.747
v2	14.303	0.71765	16.728
v3	9.2029	0.32762	45.278
Maximum concentrations	16.3	0.7	45.3

**Attachment 7**

**Pumps 2" Hose \*2 Maximum Conc. Tanks V-1, V-2, and V-3**

J745  
5/25/01  
RH

**Case Title: pump 2\*Max**  
**Description: pump modeled as 2" hose, 2\*max**  
**Geometry: 7 - Cylinder Volume - Side Shields**



**Source Dimensions**

Height	45.7 cm	1 ft 6.0 in
Radius	2.54 cm	1.0 in

**Dose Points**

	X	Y	Z
# 1	3.74 cm 1.5 in	22.85 cm 9.0 in	0 cm 0.0 in
# 2	102.74 cm 3 ft 4.4 in	22.85 cm 9.0 in	0 cm 0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	926.261 cm <sup>3</sup>	Water	1.02
Transition	.2 cm	Polyethylene CH <sub>2</sub>	0.9
Air Gap		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm <sup>3</sup>
Ba-137m	3.0196e-002	1.1173e+009	3.2600e+001	1.2062e+006
Co-60	1.3338e-003	4.9351e+007	1.4400e+000	5.3280e+004
Cs-137	3.0196e-002	1.1173e+009	3.2600e+001	1.2062e+006
Sr-90	8.3919e-002	3.1050e+009	9.0600e+001	3.3522e+006
Y-90	8.3919e-002	3.1050e+009	9.0600e+001	3.3522e+006

**Buildup**

The material reference is : Source

**Integration Parameters**

Radial	10
Circumferential	10
Y Direction (axial)	20

**Results - Dose Point # 1 - (3.74,22.85,0) cm**

Energy MeV	Activity photons/sec	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		MeV/cm <sup>2</sup> /sec	MeV/cm <sup>2</sup> /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.0318	2.313e+07	4.038e+02	8.489e+02	3.363e+00	7.071e+00
0.0322	4.268e+07	7.617e+02	1.618e+03	6.130e+00	1.302e+01
0.0364	1.553e+07	3.434e+02	8.083e+02	1.951e+00	4.593e+00
0.6616	1.005e+09	6.833e+05	8.927e+05	1.325e+03	1.731e+03

Page : 2

DOS File : PUMP-MX.MS5

Run Date: May 13, 2001

Run Time: 8:42:37 AM

Duration : 00:00:06

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.6938	8.050e+03	5.773e+00	7.473e+00	1.115e-02	1.443e-02
1.1732	4.935e+07	6.385e+04	7.635e+04	1.141e+02	1.364e+02
1.3325	4.935e+07	7.359e+04	8.655e+04	1.277e+02	1.502e+02
TOTALS:	1.185e+09	8.223e+05	1.059e+06	1.578e+03	2.042e+03

**Results - Dose Point # 2 - (102.74,22.85,0) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	2.313e+07	2.526e+00	5.234e+00	2.104e-02	4.359e-02
0.0322	4.268e+07	4.762e+00	9.945e+00	3.833e-02	8.004e-02
0.0364	1.553e+07	2.132e+00	4.803e+00	1.211e-02	2.729e-02
0.6616	1.005e+09	3.914e+03	4.776e+03	7.587e+00	9.258e+00
0.6938	8.050e+03	3.302e-02	4.000e-02	6.375e-05	7.723e-05
1.1732	4.935e+07	3.596e+02	4.098e+02	6.427e-01	7.323e-01
1.3325	4.935e+07	4.130e+02	4.647e+02	7.165e-01	8.062e-01
TOTALS:	1.185e+09	4.696e+03	5.670e+03	9.018e+00	1.095e+01

RH  
5-25-01

### Pump results

Exposure Rates in mR/h at Contact (e.g. 1-cm) and 1 m from pump  
 Based on Microshield estimates, 50' length, 2"" ID, 2mm polyethylene wall.

	mR/h @ 1-cm	mR/h @ 100-cm
Average , tanks V-1, V-2, V-3	1268	6.8
Maximum , tanks V-1, V-2, V-3	2042	10.9

### Hose Dimensions for the pump

length, ft	cm/in	in/ft	cm
1.5	2.54	12	45.72

radius, in	cm
1	2.54

volume ( $\pi * r^2 * h$ )

926.67 cm<sup>3</sup>

### Sludge Concentration values in uCi/cc for Tanks V-1, V-2, V-3

#### Fot Pump Calculations

Concentrations for pump is 2x the concentrations used for Hose Calcs  
 to account for the assumption that an equivalent volume as 2 hoses are present.

	Cs-137	Co-60	Sr-90
2*Average of Average concentrations for tanks V	20.7	0.77	31.1
2* Maximum Concentrations for tanks V-1, V-2,	32.6	1.44	90.6

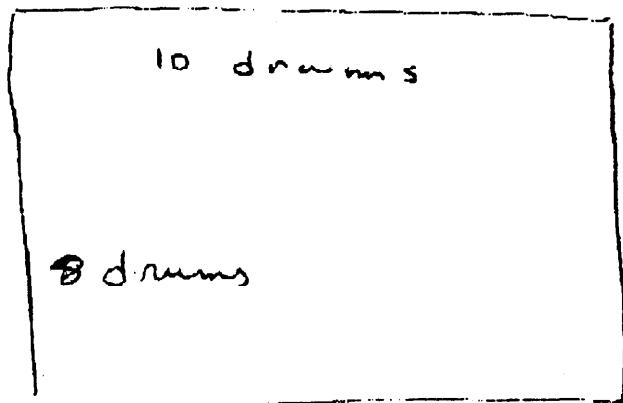
Factors to support Microshield and MCNP-4C calculation for Storage Area

effective area per area drum, cm^2      drum      density drum      density, 2771.167464      28277.172      1.4      0.1372 slab				equivalent circular area assumed for MCNP skyshine calculation: 848.5707 cm radius					
height	height, in								
27	10.62992126								
		Curies per drum		Detector positions from shield:					
<b>V-3 average</b>		<b>total curie:</b>							
	Cs-137	61.976	0.7747			940.0107 inner wall of shield			
	Co-60	1.5304	0.01913						
	Sr-90	176.64	2.208						
<b>V-3 maximum</b>		73.784	0.9223	3'	1056.451 evaluation distances				
	Co-60	2.6272	0.03284	10'	1268.011				
	Sr-90	363.016	4.5377	50'	2480.011				
				Curies		photon energy frequency of photon emissions			
				73.78	Ci, Ba-137m	662	65.6642		
				2.622	Ci, Co-60	1100	2.622		
						1300	2.622		
				photons emitted/h	mrad per mev/g	Tally multiplier mrad/h per MeV/g			
				9.44497E+15	6.25E+04	1.51E+11			

10-25-07  
RH

Length - V tank drum storage Microshield factors  
 27 cm high average & worst case  
 data from drum V-3. Density 1.4.  
 8 foot centers = 54 feet + 2 drum radius  
 $\approx 56$  feet long.  $[10-1] \times 6 + 2$

Width -  
 $8 \text{ drums} \times 6 \text{ foot centers} + 2 \text{ drum radius}$   
 $\approx \frac{44}{44} \text{ feet}$   $[8-1] \times 6 + 2$



Scale density to account for slab geometry.

$$\frac{\pi r^2}{L \times W} \times \rho = \rho_{\text{equiv slab}}$$

$$\frac{\pi (29.7)^2}{56 \cdot 44 \cdot (0.303)^2} \times \frac{1.4}{R_H} = 0.1372$$

Rule Hader  
4-24-01

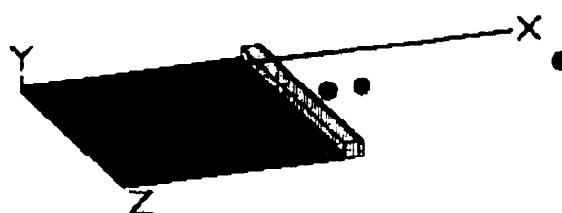
111146

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : STOREANS.MSS  
Run Date: May 24, 2001  
Run Time: 12:16:19 PM  
Duration : 00:01:12

File Ref: \_\_\_\_\_  
Date: 5-25-01  
By: LH  
Checked: \_\_\_\_\_

**Case Title: V-3 average**  
**Description: V-3 avg., storage area, with air gap not concrete shield**  
**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	1.3e+3 cm	44 ft
Width	1.7e+3 cm	56 ft 0.0 in
Height	26.923 cm	10.6 in

**Dose Points**

	X	Y	Z
# 1	1.56e+03 cm 51 ft 1.6 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in
# 2	1.76e+03 cm 57 ft 10.0 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in
# 3	2.98e+03 cm 97 ft 10.0 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	6.16e+07 cm <sup>3</sup>	Water	0.1372
Shield 1	91.44 cm	Air	0.00122
Shield 2	25.298 cm	Air	0.00122
Air Gap		Air	0.00122
Immersion		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	$\text{Bq}/\text{cm}^3$
Ba-137m	6.1976e+001	2.2931e+012	1.0056e+000	3.7208e+004
Co-60	1.5300e+000	5.6610e+010	2.4825e-002	9.1854e+002
Cs-137	6.1976e+001	2.2931e+012	1.0056e+000	3.7208e+004
Sr-90	1.7660e+002	6.5342e+012	2.8655e+000	1.0602e+005
Y-90	1.7660e+002	6.5342e+012	2.8655e+000	1.0602e+005

**Buildup**

The material reference is : Source

**Integration Parameters**

X Direction	100
Y Direction	8

Page : 2  
 DOS File : STOREANS.MS5  
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 Duration : 00:01:12

Z Direction

25

**Results - Dose Point # 1 - (1.56e+03,100.584,853.44) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.747e+10	2.347e+01	6.018e+01	1.955e-01	5.013e-01
0.0322	8.759e+10	4.454e+01	1.162e+02	3.585e-01	9.348e-01
0.0364	3.187e+10	2.128e+01	6.638e+01	1.209e-01	3.771e-01
0.6616	2.063e+12	6.873e+04	1.309e+05	1.332e+02	2.537e+02
0.6938	9.234e+06	3.272e-01	6.119e-01	6.317e-04	1.181e-03
1.1732	5.661e+10	3.972e+03	6.293e+03	7.099e+00	1.125e+01
1.3325	5.661e+10	4.683e+03	7.159e+03	8.126e+00	1.242e+01
TOTALS:	2.344e+12	7.747e+04	1.446e+05	1.491e+02	2.792e+02

**Results - Dose Point # 2 - (1.76e+03,100.584,853.44) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.747e+10	9.775e+00	2.656e+01	8.142e-02	2.212e-01
0.0322	8.759e+10	1.858e+01	5.139e+01	1.496e-01	4.136e-01
0.0364	3.187e+10	9.015e+00	3.008e+01	5.122e-02	1.709e-01
0.6616	2.063e+12	3.323e+04	7.093e+04	6.442e+01	1.375e+02
0.6938	9.234e+06	1.586e-01	3.319e-01	3.063e-04	6.409e-04
1.1732	5.661e+10	1.987e+03	3.449e+03	3.551e+00	6.163e+00
1.3325	5.661e+10	2.362e+03	3.935e+03	4.097e+00	6.828e+00
TOTALS:	2.344e+12	3.762e+04	7.842e+04	7.235e+01	1.513e+02

**Results - Dose Point # 3 - (2.98e+03,100.584,853.44) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.747e+10	6.396e-01	2.147e+00	5.328e-03	1.788e-02
0.0322	8.759e+10	1.225e+00	4.192e+00	9.860e-03	3.374e-02
0.0364	3.187e+10	6.340e-01	2.658e+00	3.602e-03	1.510e-02
0.6616	2.063e+12	3.286e+03	8.630e+03	6.371e+00	1.673e+01
0.6938	9.234e+06	1.577e-02	4.051e-02	3.045e-05	7.821e-05
1.1732	5.661e+10	2.105e+02	4.380e+02	3.762e-01	7.827e-01
1.3325	5.661e+10	2.545e+02	5.057e+02	4.416e-01	8.774e-01

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 DOS File : STOREANS.MS5  
 Run Date : May 24, 2001  
 Run Time: 12:16:19 PM  
 Duration : 00:01:12

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
TOTALS:	2.344e+12	3.754e+03	9.583e+03	7.208e+00	1.846e+01

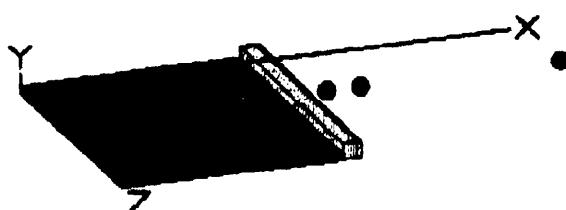
17-110

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : STOREMNS.MS5  
Run Date: May 24, 2001  
Run Time: 12:23:02 PM  
Duration : 00:01:12

File Ref: \_\_\_\_\_  
Date: 5-25-01  
By: RH  
Checked: \_\_\_\_\_

**Case Title: V-3 maximum**  
**Description: V-3 max., storage area, air gap not concrete shield**  
**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	1.3e+3 cm	44 ft
Width	1.7e+3 cm	56 ft 0.0 in
Height	26.923 cm	10.6 in

**Dose Points**

	X	Y	Z
# 1	1.56e+03 cm 51 ft 1.6 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in
# 2	1.76e+03 cm 57 ft 10.0 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in
# 3	2.98e+03 cm 97 ft 10.0 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	6.16e+07 cm <sup>3</sup>	Water	0.1372
Shield 1	91.44 cm	Air	0.00122
Shield 2	25.298 cm	Air	0.00122
Air Gap		Air	0.00122
Immersion		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	$\text{Bq}/\text{cm}^3$
Ba-137m	7.3784e+001	2.7300e+012	1.1972e+000	4.4297e+004
Co-60	2.6220e+000	9.7014e+010	4.2544e-002	1.5741e+003
Cs-137	7.3784e+001	2.7300e+012	1.1972e+000	4.4297e+004
Sr-90	3.6302e+002	1.3432e+013	5.8902e+000	2.1794e+005
Y-90	3.6302e+002	1.3432e+013	5.8902e+000	2.1794e+005

**Buildup**

The material reference is : Source

**Integration Parameters**

X Direction	100
Y Direction	8
Z Direction	25

Page : 2  
DOS File : STOREMNS.MS5  
Run Date: May 24, 2001  
Run Time: 12:23:02 PM  
Duration : 00:01:12

**Results - Dose Point # 1 - (1.56e+03,100.584,853.44) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.652e+10	2.794e+01	7.164e+01	2.327e-01	5.968e-01
0.0322	1.043e+11	5.303e+01	1.383e+02	4.268e-01	1.113e+00
0.0364	3.795e+10	2.533e+01	7.903e+01	1.439e-01	4.490e-01
0.6616	2.456e+12	8.182e+04	1.558e+05	1.586e+02	3.020e+02
0.6938	1.582e+07	5.608e-01	1.049e+00	1.083e-03	2.025e-03
1.1732	9.701e+10	6.808e+03	1.079e+04	1.217e+01	1.927e+01
1.3325	9.701e+10	8.026e+03	1.227e+04	1.392e+01	2.129e+01
TOTALS:	2.849e+12	9.676e+04	1.791e+05	1.855e+02	3.447e+02

**Results - Dose Point # 2 - (1.76e+03,100.584,853.44) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.652e+10	1.164e+01	3.162e+01	9.693e-02	2.634e-01
0.0322	1.043e+11	2.212e+01	6.118e+01	1.780e-01	4.924e-01
0.0364	3.795e+10	1.073e+01	3.581e+01	6.098e-02	2.035e-01
0.6616	2.456e+12	3.956e+04	8.445e+04	7.670e+01	1.637e+02
0.6938	1.582e+07	2.719e-01	5.688e-01	5.249e-04	1.098e-03
1.1732	9.701e+10	3.406e+03	5.910e+03	6.086e+00	1.056e+01
1.3325	9.701e+10	4.047e+03	6.744e+03	7.022e+00	1.170e+01
TOTALS:	2.849e+12	4.706e+04	9.723e+04	9.014e+01	1.869e+02

**Results - Dose Point # 3 - (2.98e+03,100.584,853.44) cm**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.652e+10	7.615e-01	2.556e+00	6.343e-03	2.129e-02
0.0322	1.043e+11	1.459e+00	4.991e+00	1.174e-02	4.016e-02
0.0364	3.795e+10	7.547e-01	3.164e+00	4.288e-03	1.798e-02
0.6616	2.456e+12	3.912e+03	1.027e+04	7.585e+00	1.992e+01
0.6938	1.582e+07	2.703e-02	6.942e-02	5.218e-05	1.340e-04
1.1732	9.701e+10	3.608e+02	7.506e+02	6.448e-01	1.341e+00
1.3325	9.701e+10	4.362e+02	8.667e+02	7.567e-01	1.504e+00
TOTALS:	2.849e+12	4.712e+03	1.190e+04	9.009e+00	2.284e+01

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

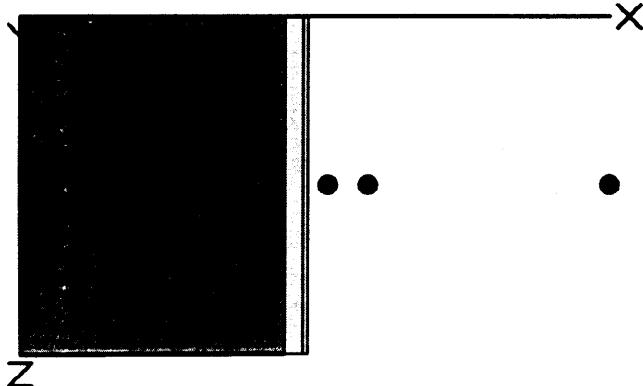
Page : 1  
 DOS File : STORAGEM.MS5  
 Date: May 24, 2001  
 Run Time: 5:26:21 AM  
 Duration : 00:01:24

File Ref: \_\_\_\_\_  
 Date: 5-25-01/  
 By: KH  
 Checked: \_\_\_\_\_

**Case Title: V-3 maximum**

**Description: V-3 maximum, storage area, 10" concrete shield**

**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	1.3e+3 cm	44 ft 0.0 in
Width	1.7e+3 cm	56 ft 0.0 in
Height	26.923 cm	10.6 in

**Dose Points**

	X	Y	Z
# 1	1.56e+03 cm 51 ft 1.6 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in
# 2	1.76e+03 cm 57 ft 10.0 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in
# 3	2.98e+03 cm 97 ft 10.0 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	2176.451 ft <sup>3</sup>	Water	0.1372
Shield 1	3.0 ft	Air	0.00122
Shield 2	.83 ft	Concrete	2.35
Air Gap		Air	0.00122
Immersion		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm <sup>3</sup>
Ba-137m	7.3784e+001	2.7300e+012	1.1972e+000	4.4297e+004
Co-60	2.6220e+000	9.7014e+010	4.2544e-002	1.5741e+003
Cs-137	7.3784e+001	2.7300e+012	1.1972e+000	4.4297e+004
Sr-90	3.6302e+002	1.3432e+013	5.8902e+000	2.1794e+005
Y-90	3.6302e+002	1.3432e+013	5.8902e+000	2.1794e+005

**Buildup**

**The material reference is : Shield 2**

**Integration Parameters**

X Direction	100
Y Direction	8
Z Direction	25

Page : 2

DOS File : STORAGEM.MS5

Run Date: May 24, 2001

Run Time: 5:26:21 AM

Duration : 00:01:24

**Results - Dose Point # 1 - (51.13,3.3,28) ft**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.652e+10	7.121e-26	4.351e-24	5.932e-28	3.624e-26
0.0322	1.043e+11	7.834e-25	9.317e-24	6.305e-27	7.498e-26
0.0364	3.795e+10	1.319e-18	4.149e-18	7.495e-21	2.357e-20
0.6616	2.456e+12	3.917e+02	5.025e+03	7.593e-01	9.743e+00
0.6938	1.582e+07	2.988e-03	3.630e-02	5.769e-06	7.008e-05
1.1732	9.701e+10	1.103e+02	7.460e+02	1.971e-01	1.333e+00
1.3325	9.701e+10	1.662e+02	9.867e+02	2.884e-01	1.712e+00
TOTALS:	2.849e+12	6.682e+02	6.758e+03	1.245e+00	1.279e+01

**Results - Dose Point # 2 - (57.83,3.3,28) ft**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.652e+10	6.419e-26	2.654e-24	5.347e-28	2.211e-26
0.0322	1.043e+11	7.013e-25	6.049e-24	5.644e-27	4.868e-26
0.0364	3.795e+10	1.096e-18	3.445e-18	6.226e-21	1.957e-20
0.6616	2.456e+12	2.340e+02	3.028e+03	4.537e-01	5.870e+00
0.6938	1.582e+07	1.786e-03	2.189e-02	3.449e-06	4.226e-05
1.1732	9.701e+10	6.652e+01	4.545e+02	1.189e-01	8.121e-01
1.3325	9.701e+10	1.005e+02	6.027e+02	1.744e-01	1.046e+00
TOTALS:	2.849e+12	4.011e+02	4.085e+03	7.470e-01	7.728e+00

**Results - Dose Point # 3 - (97.83,3.3,28) ft**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	5.652e+10	1.316e-26	5.329e-25	1.096e-28	4.439e-27
0.0322	1.043e+11	1.429e-25	1.223e-24	1.150e-27	9.842e-27
0.0364	3.795e+10	2.108e-19	6.628e-19	1.198e-21	3.766e-21
0.6616	2.456e+12	3.459e+01	4.484e+02	6.706e-02	8.693e-01
0.6938	1.582e+07	2.641e-04	3.244e-03	5.099e-07	6.262e-06
1.1732	9.701e+10	9.874e+00	6.812e+01	1.765e-02	1.217e-01
1.3325	9.701e+10	1.496e+01	9.074e+01	2.595e-02	1.574e-01
TOTALS:	2.849e+12	5.943e+01	6.073e+02	1.107e-01	1.148e+00

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

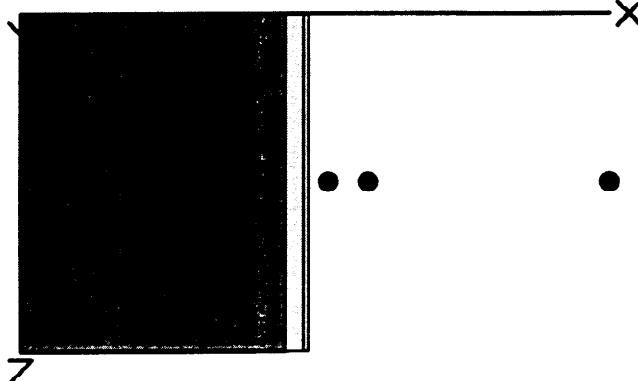
Page : 1  
PSS File : STORAGEA.MS5  
Run Date: May 24, 2001  
Run Time: 5:14:15 AM  
Duration : 00:01:23

File Ref:  
Date: 3-25-01  
By: RH  
Checked: \_\_\_\_\_

**Case Title: V-3 average**

**Description: V-3 average, storage area, 10" concrete shield**

**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	1.3e+3 cm	44 ft 0.0 in
Width	1.7e+3 cm	56 ft 0.0 in
Height	26.923 cm	10.6 in

**Dose Points**

	X	Y	Z
# 1	1.56e+03 cm 51 ft 1.6 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in
# 2	1.76e+03 cm 57 ft 10.0 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in
# 3	2.98e+03 cm 97 ft 10.0 in	100.584 cm 3 ft 3.6 in	853.44 cm 28 ft 0.0 in

**Shields**

Shield Name	Dimension	Material	Density
Source	2176.451 ft <sup>3</sup>	Water	0.1372
Shield 1	3.0 ft	Air	0.00122
Shield 2	.83 ft	Concrete	2.35
Air Gap		Air	0.00122
Immersion		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/ $\text{cm}^3$
Ba-137m	6.1976e+001	2.2931e+012	1.0056e+000	3.7208e+004
Co-60	1.5300e+000	5.6610e+010	2.4825e-002	9.1854e+002
Cs-137	6.1976e+001	2.2931e+012	1.0056e+000	3.7208e+004
Sr-90	1.7660e+002	6.5342e+012	2.8655e+000	1.0602e+005
Y-90	1.7660e+002	6.5342e+012	2.8655e+000	1.0602e+005

**Buildup**

The material reference is : Shield 2

**Integration Parameters**

X Direction	100
Y Direction	8

Page : 2  
 DOS File : STORAGEA.MS5  
 Run Date: May 24, 2001  
 Run Time: 5:14:15 AM  
 Duration : 00:01:23

Z Direction

25

**Results - Dose Point # 1 - (51.13,3.3,28) ft**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.747e+10	5.981e-26	3.655e-24	4.982e-28	3.044e-26
0.0322	8.759e+10	6.580e-25	7.826e-24	5.296e-27	6.298e-26
0.0364	3.187e+10	1.108e-18	3.485e-18	6.296e-21	1.980e-20
0.6616	2.063e+12	3.290e+02	4.221e+03	6.378e-01	8.183e+00
0.6938	9.234e+06	1.744e-03	2.118e-02	3.366e-06	4.089e-05
1.1732	5.661e+10	6.435e+01	4.353e+02	1.150e-01	7.779e-01
1.3325	5.661e+10	9.700e+01	5.757e+02	1.683e-01	9.989e-01
TOTALS:	2.344e+12	4.903e+02	5.232e+03	9.211e-01	9.960e+00

**Results - Dose Point # 2 - (57.83,3.3,28) ft**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.747e+10	5.392e-26	2.230e-24	4.491e-28	1.857e-26
0.0322	8.759e+10	5.891e-25	5.081e-24	4.741e-27	4.089e-26
0.0364	3.187e+10	9.205e-19	2.894e-18	5.230e-21	1.644e-20
0.6616	2.063e+12	1.966e+02	2.543e+03	3.811e-01	4.931e+00
0.6938	9.234e+06	1.042e-03	1.277e-02	2.013e-06	2.466e-05
1.1732	5.661e+10	3.881e+01	2.652e+02	6.936e-02	4.739e-01
1.3325	5.661e+10	5.866e+01	3.517e+02	1.018e-01	6.101e-01
TOTALS:	2.344e+12	2.940e+02	3.160e+03	5.522e-01	6.015e+00

**Results - Dose Point # 3 - (97.83,3.3,28) ft**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.747e+10	1.105e-26	4.476e-25	9.208e-29	3.728e-27
0.0322	8.759e+10	1.200e-25	1.027e-24	9.661e-28	8.267e-27
0.0364	3.187e+10	1.771e-19	5.567e-19	1.006e-21	3.163e-21
0.6616	2.063e+12	2.906e+01	3.767e+02	5.633e-02	7.302e-01
0.6938	9.234e+06	1.541e-04	1.893e-03	2.975e-07	3.654e-06
1.1732	5.661e+10	5.762e+00	3.975e+01	1.030e-02	7.103e-02
1.3325	5.661e+10	8.729e+00	5.295e+01	1.514e-02	9.187e-02

Page : 3

DOS File : STORAGEA.MS5

Run Date: May 24, 2001

Run Time: 5:14:15 AM

Duration : 00:01:23

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		No Buildup	With Buildup	No Buildup	With Buildup
TOTALS:	2.344e+12	4.355e+01	4.694e+02	8.177e-02	8.931e-01

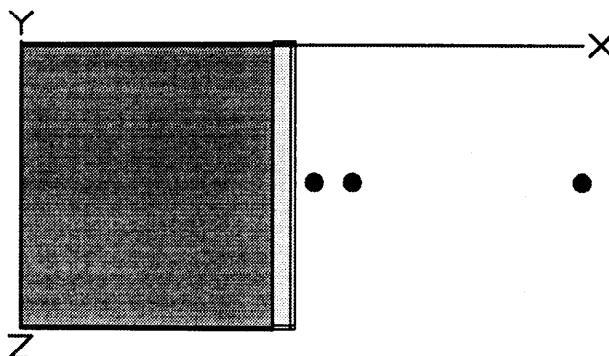
**Attachment 8****Dose from Drums in Storage with and without Shielding with Concrete**

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : STWOSHLD.MS5  
Run Date: September 27, 2001  
Run Time: 5:57:56 AM  
Duration : 00:01:54

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: Staging not shielded**  
**Description: Staging area, dewatered not shielded**  
**Geometry: 13 - Rectangular Volume**



<b>Source Dimensions</b>			
Length	1.3e+3 cm	44 ft	
Width	1.5e+3 cm	50 ft	
Height	30.48 cm	1 ft	

<b>Dose Points</b>			
# 1	X 1.56e+03 cm 51 ft 1.6 in	Y 100.584 cm 3 ft 3.6 in	Z 762 cm 25 ft
# 2	1.76e+03 cm 57 ft 10.0 in	100.584 cm 3 ft 3.6 in	762 cm 25 ft
# 3	2.98e+03 cm 97 ft 10.0 in	100.584 cm 3 ft 3.6 in	762 cm 25 ft

<b>Shields</b>				
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>	
Source	2200.0 ft <sup>3</sup>	Water	0.132	
Shield 1	3.0 ft	Air	0.00122	
Shield 2	.83 ft	Air	0.00122	
Air Gap		Air	0.00122	
Immersion		Air	0.00122	

**Source Input**  
**Grouping Method : Actual Photon Energies**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u><math>\mu\text{Ci}/\text{cm}^3</math></u>	<u>Bq/cm<sup>3</sup></u>
Ba-137m	5.4319e+001	2.0098e+012	8.7194e-001	3.2262e+004
Co-60	7.2600e+000	2.6862e+011	1.1654e-001	4.3119e+003
Cs-137	5.7420e+001	2.1245e+012	9.2171e-001	3.4103e+004

**Buildup**  
The material reference is : Source

**Integration Parameters**

X Direction	100
Y Direction	10
Z Direction	100

**Results - Dose Point # 1 - (51.13,3.3,25) ft**

Page : 2

DOS File : STWOSHLD.MS5

Run Date : September 27, 2001

Run Time: 5:57:56 AM

Duration : 00:01:54

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.161e+10	2.103e+01	5.369e+01	1.752e-01	4.472e-01
0.0322	7.677e+10	3.991e+01	1.036e+02	3.212e-01	8.340e-01
0.0364	2.794e+10	1.905e+01	5.921e+01	1.082e-01	3.364e-01
0.6616	1.808e+12	6.189e+04	1.195e+05	1.200e+02	2.317e+02
0.6938	4.382e+07	1.596e+00	3.026e+00	3.081e-03	5.843e-03
1.1732	2.686e+11	1.944e+04	3.118e+04	3.475e+01	5.572e+01
1.3325	2.686e+11	2.295e+04	3.549e+04	3.981e+01	6.157e+01
TOTALS:	2.492e+12	1.044e+05	1.864e+05	1.952e+02	3.507e+02

**Results - Dose Point # 2 - (57.83,3.3,25) ft**

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.161e+10	8.684e+00	2.342e+01	7.233e-02	1.951e-01
0.0322	7.677e+10	1.650e+01	4.530e+01	1.328e-01	3.646e-01
0.0364	2.794e+10	7.992e+00	2.646e+01	4.541e-02	1.503e-01
0.6616	1.808e+12	2.930e+04	6.306e+04	5.679e+01	1.223e+02
0.6938	4.382e+07	7.572e-01	1.598e+00	1.462e-03	3.085e-03
1.1732	2.686e+11	9.507e+03	1.665e+04	1.699e+01	2.976e+01
1.3325	2.686e+11	1.131e+04	1.902e+04	1.962e+01	3.299e+01
TOTALS:	2.492e+12	5.014e+04	9.883e+04	9.365e+01	1.857e+02

**Results - Dose Point # 3 - (97.83,3.3,25) ft**

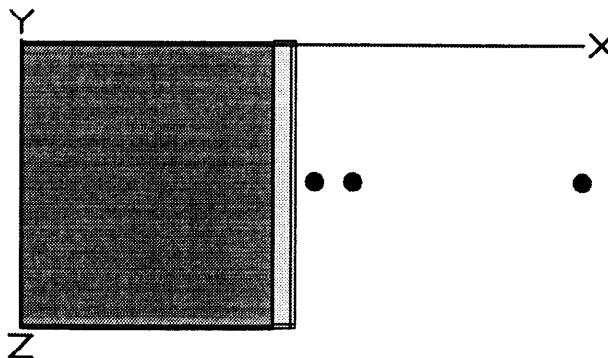
<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.161e+10	5.539e-01	1.841e+00	4.614e-03	1.533e-02
0.0322	7.677e+10	1.061e+00	3.593e+00	8.535e-03	2.892e-02
0.0364	2.794e+10	5.473e-01	2.274e+00	3.110e-03	1.292e-02
0.6616	1.808e+12	2.811e+03	7.362e+03	5.450e+00	1.427e+01
0.6938	4.382e+07	7.303e-02	1.871e-01	1.410e-04	3.612e-04
1.1732	2.686e+11	9.742e+02	2.025e+03	1.741e+00	3.618e+00
1.3325	2.686e+11	1.177e+03	2.339e+03	2.043e+00	4.057e+00
TOTALS:	2.492e+12	4.965e+03	1.173e+04	9.250e+00	2.201e+01

**MicroShield v5.03 (5.03-00090)**  
**AQ Safety, Inc.**

Page : 1  
DOS File : ST&SHLD.MS5  
Run Date: September 27, 2001  
Run Time: 5:47:50 AM  
Duration : 00:02:14

File Ref: \_\_\_\_\_  
Date: \_\_\_\_\_  
By: \_\_\_\_\_  
Checked: \_\_\_\_\_

**Case Title: Staging shielded**  
**Description: Staging area, shielded & dewatered**  
**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	1.3e+3 cm	44 ft
Width	1.5e+3 cm	50 ft
Height	30.48 cm	1 ft

**Dose Points**

#	X	Y	Z
# 1	1.56e+03 cm 51 ft 1.6 in	100.584 cm 3 ft 3.6 in	762 cm 25 ft
# 2	1.76e+03 cm 57 ft 10.0 in	100.584 cm 3 ft 3.6 in	762 cm 25 ft
# 3	2.98e+03 cm 97 ft 10.0 in	100.584 cm 3 ft 3.6 in	762 cm 25 ft

**Shields**

Shield Name	Dimension	Material	Density
Source	2200.0 ft <sup>3</sup>	Water	0.132
Shield 1	3.0 ft	Air	0.00122
Shield 2	.83 ft	Concrete	2.35
Air Gap		Air	0.00122
Immersion		Air	0.00122

**Source Input**

**Grouping Method : Actual Photon Energies**

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	$\text{Bq}/\text{cm}^3$
Ba-137m	5.4319e+001	2.0098e+012	8.7194e-001	3.2262e+004
Co-60	7.2600e+000	2.6862e+011	1.1654e-001	4.3119e+003
Cs-137	5.7420e+001	2.1245e+012	9.2171e-001	3.4103e+004

**Buildup**

The material reference is : Shield 2

**Integration Parameters**

X Direction	100
Y Direction	10
Z Direction	100

**Results - Dose Point # 1 - (51.13,3.3,25) ft**

Page : 2

DOS File : ST&amp;SHLD.MS5

Run Date: September 27, 2001

Run Time: 5:47:50 AM

Duration : 00:02:14

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.161e+10	5.531e-26	3.407e-24	4.607e-28	2.838e-26
0.0322	7.677e+10	6.082e-25	7.293e-24	4.895e-27	5.870e-26
0.0364	2.794e+10	1.021e-18	3.210e-18	5.799e-21	1.824e-20
0.6616	1.808e+12	3.032e+02	3.905e+03	5.878e-01	7.571e+00
0.6938	4.382e+07	8.702e-03	1.061e-01	1.680e-05	2.049e-04
1.1732	2.686e+11	3.224e+02	2.189e+03	5.761e-01	3.911e+00
1.3325	2.686e+11	4.864e+02	2.898e+03	8.439e-01	5.027e+00
TOTALS:	2.492e+12	1.112e+03	8.992e+03	2.008e+00	1.651e+01

<b>Results - Dose Point # 2 - (57.83,3.3,25) ft</b>					
<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.161e+10	4.976e-26	2.043e-24	4.145e-28	1.701e-26
0.0322	7.677e+10	5.434e-25	4.665e-24	4.373e-27	3.754e-26
0.0364	2.794e+10	8.464e-19	2.661e-18	4.809e-21	1.512e-20
0.6616	1.808e+12	1.787e+02	2.314e+03	3.464e-01	4.485e+00
0.6938	4.382e+07	5.130e-03	6.291e-02	9.904e-06	1.215e-04
1.1732	2.686e+11	1.912e+02	1.308e+03	3.417e-01	2.337e+00
1.3325	2.686e+11	2.890e+02	1.735e+03	5.014e-01	3.010e+00
TOTALS:	2.492e+12	6.589e+02	5.357e+03	1.189e+00	9.833e+00

<b>Results - Dose Point # 3 - (97.83,3.3,25) ft</b>					
<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Fluence Rate</u> <u>MeV/cm<sup>2</sup>/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.0318	4.161e+10	1.039e-26	3.968e-25	8.654e-29	3.306e-27
0.0322	7.677e+10	1.128e-25	9.177e-25	9.075e-28	7.386e-27
0.0364	2.794e+10	1.654e-19	5.198e-19	9.395e-22	2.953e-21
0.6616	1.808e+12	2.540e+01	3.273e+02	4.923e-02	6.346e-01
0.6938	4.382e+07	7.288e-04	8.902e-03	1.407e-06	1.719e-05
1.1732	2.686e+11	2.711e+01	1.862e+02	4.845e-02	3.327e-01
1.3325	2.686e+11	4.103e+01	2.479e+02	7.118e-02	4.300e-01
TOTALS:	2.492e+12	9.353e+01	7.614e+02	1.689e-01	1.397e+00